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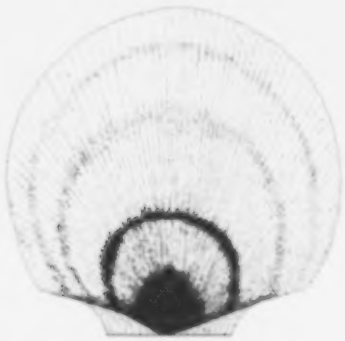
Canadian Science Advisory Secretariat
Science Advisory Report 2013/058

# ASSESSMENT OF GEORGES BANK SCALLOPS (*PLACOPECTEN MAGELLANICUS*)



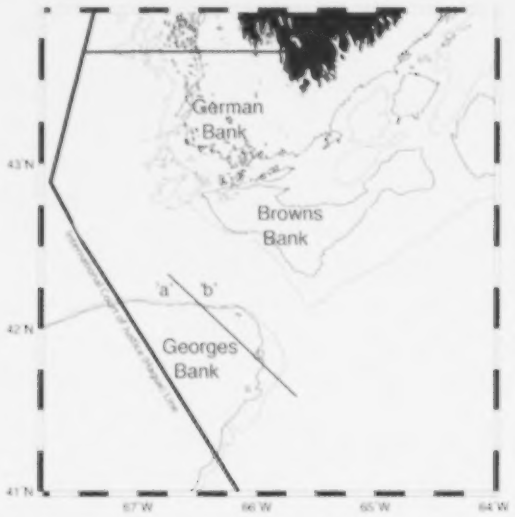



*Figure 1. Location of Georges Bank 'a' and 'b'.*

## Context:

*The sea scallop, Placopecten magellanicus, is found only in the Northwest Atlantic, from Cape Hatteras to Labrador. Scallops are aggregated in patches and harvestable concentrations are called beds. Major areas of offshore fishing activity are Georges Bank, Browns Bank, German Bank, the Eastern Scotian Shelf (Banquereau, Middle Bank, Sable and Western banks), and St. Pierre Bank (south of Newfoundland). Scallops prefer a sandy, gravel bottom and occur in depths of 35 to 120 m on the offshore banks.*

*The offshore scallop fleet consists of wet fish vessels and freezer-trawlers. Generally, these vessels simultaneously fish two New Bedford offshore rakes, ranging from 4.3 to 5.2 m width, one on each side of the vessel.*

*Annual assessments of the status of the offshore scallop resource take into account the annual survey findings, meat size distribution in the catch, and fishery performance. The management of the main scallop fishery on Georges Bank refers to zone 'a'. Georges Bank zone 'b' is a marginal growth area for scallops and has separate management measures. The assessment and advice presented in this document use the assessment framework established in 2009 and are for Georges Bank zone 'a' only; some elements of the fishery in zone 'b' are also presented for historical purposes.*

*In support of management of the Georges Bank 2013 scallop fishery, a meeting of the Science Advisory Process was held 1 May 2013 at the Bedford Institute of Oceanography in Dartmouth, N.S., to: (1) assess the status of the resource; (2) provide harvest advice for the 2013 fishery; and (3) document by-catch in the fishery.*



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## SUMMARY


- The 2012 total allowable catch (TAC) was 4,000 t for zone 'a' and 50 t for zone 'b'. Total reported landings were 4,001 t for zone 'a' and 47 t for zone 'b'.
- The commercial catch rate for zone 'a' has increased from 17.31 kg/hm in 2011 to 20.64 kg/hm 2012 and is above the long-term median of 10.15 kg/hm
- By-catch estimates of yellowtail flounder were 46 t in 2012 and were very similar to discards in 2011 of 51 t. Estimated discards of cod increased from 29 t in 2011 to 41 t in 2012, and estimated discards of haddock increased from 15 t in 2011 to 28 t in 2012.
- The survey indices for recruits and fully recruited scallops were above their respective 31-year median levels in 2012 while the index for pre-recruits was at the 31-year median level. The abundance of recruits and fully recruited scallops has decreased from 120 and 182 scallops per tow in 2011 to 58 and 158 scallops per tow in 2012, respectively
- Fully recruited biomass, estimated to be 23,400 t in 2012, increased from the 2011 estimate (21,370 t) and was above the 26-year median biomass of 14,810 t. Recruit biomass, estimated to be 4,685 t in 2012 declined from the 2011 estimate (7,657 t), but was still above the 26-year median biomass of 2,995 t.
- The 2013 interim TAC of 4,000 t is expected to result in an exploitation rate of 0.16, and incoming recruitment is expected to be above the median. Harvest scenarios ranging from 2,000 to 6,000 t are all predicted to yield increases in commercial biomass for 2013 with a probability of decline ranging from 0.36 to 0.48.


## BACKGROUND

A meeting of the Science Advisory Process was held 1 May 2013 at the Bedford Institute of Oceanography (BIO), in Dartmouth, Nova Scotia to review the 2012 fishery and assess the status of the scallop stock on Georges Bank in support of the management of the 2013 fishery. Participants included DFO scientists, fishery managers, representatives of Aboriginal organizations, and representatives of the industry.

## ASSESSMENT

### Fishery

The 2012 TAC was 4,000 t for zone 'a' and 50 t for zone 'b' (Table 2). Total reported landings were 4,001 t for zone 'a' and 47 t for zone 'b'. Based upon preliminary analysis of the 2012 fishery data and the annual stock survey data, an interim TAC of 4,000 t was set for the 2013 Georges Bank zone 'a' fishery and 100 t for zone 'b'. Effort measured on Georges 'a' in hours fished multiplied by gear width in metres (hm) decreased from 260,937 hm in 2011 to 193,869 hm 2012. Catch rate has increased from 17.31 kg/hm in 2011 to 20.64 kg/hm 2012 and is above the long-term median of 10.15 kg/hm (Figure 2).

*Table 1. Canadian landings of sea scallop meats from Georges Bank and total allowable catch (TAC), in metric tons. Since 1998, Georges Bank has been divided into zones 'a' and 'b'.*

| Year | Catch (t) | TAC (t) |
|---|---|---|
| 1981 | 7612 | -- |
| 1982 | 3918 | -- |
| 1983 | 2418 | -- |
| 1984 | 1945 | -- |
| 1985 | 3812 | -- |
| 1986 | 4900 | 4300 |
| 1987 | 6793 | 6850 |
| 1988 | 4336 | 5400 |
| 1989 | 4676 | 4700 |
| 1990 | 5218 | 5200 |
| 1991 | 5805 | 5800 |
| 1992 | 6151 | 6200 |
| 1993 | 6183 | 6200 |
| 1994 | 5003 | 5000 |
| 1995 | 1984 | 2000 |
| 1996 | 2996 | 3000 |
| 1997 | 4259 | 4250 |

| Year | Catch (t) | | TAC (t) | |
|---|---|---|---|---|
| | zone 'a' | zone 'b' | zone 'a' | zone 'b' |
| 1998 | 3191 | 800 | 3200 | 800 |
| 1999 | 2503 | 1196 | 2500 | 1200 |
| 2000 | 6212 | 601 | 6200 | 600 |
| 2001 | 6480 | 395 | 6500 | 400 |
| 2002 | 6469 | 192 | 6500 | 200 |
| 2003 | 5985 | 199 | 6000 | 200 |
| 2004 | 3518 | 200 | 3500 | 200 |
| 2005 | 2484 | 201 | 2500 | 200 |
| 2006 | 3932 | 162 | 4000 | 200 |
| 2007 | 4000 | 401 | 4000 | 400 |
| 2008 | 5498 | 358 | 5500 | 400 |
| 2009 | 5524 | 261 | 5500 | 350 |
| 2010 | 5300 | 66 | 5500 | 200 |
| 2011 | 4517 | 0 | 4500 | 0 |
| 2012 | 4001 | 47 | 4000 | 50 |

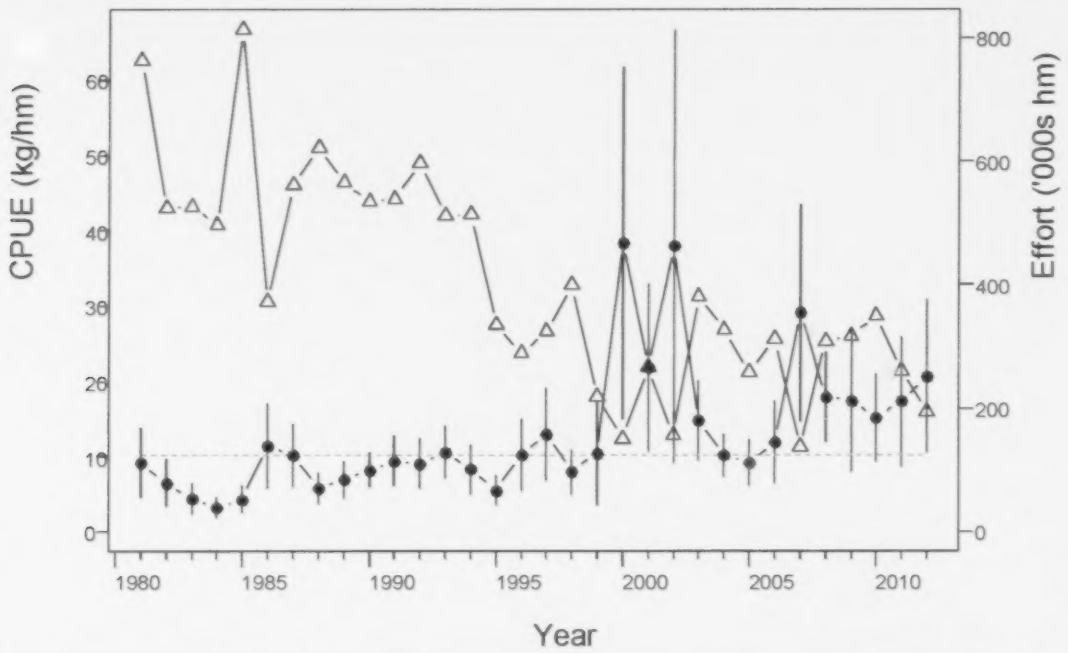


*Figure 2. Annual catch per unit effort (CPUE, kg/hm, with jackknifed standard deviations) (•) and effort (hm) (Δ), wetfish and freezer trawler fleets combined, for Georges Bank 'a'. The dashed line is the 31-year median CPUE value.*

## By-catch

By-catch of yellowtail flounder, cod and haddock were estimated using the method described in Gavaris et al. (2009). Estimated discards of yellowtail flounder were 46 t in 2012 and were very similar to discards in 2011 of 51 t. (Table 3). Estimated discards of cod increased from 29 t in 2011 to 41 t in 2012, and estimated discards of haddock increased from 15 t in 2011 to 28 t in 2012. Fishing effort increased by over 100% from 2007 to 2008 and was relatively constant from 2008 to 2010. Effort decreased from 34,617 hours (h) in 2010 to 19,031 h in 2012 (Table 2). The target for observer coverage is 2 trips per month. In 2012, this represented approximately 16% of the total hours fished.

*Table 3. Estimated effort (h) and discards (t) of yellowtail flounder (ytf), cod, and haddock (had) caught as by-catch in the scallop fishery on Georges Bank 'a' and 'b' during the years 2007 – 2012.*

| Year | Observed Effort (h) | Total Effort (h) | Species | Total Estimated Discards (t) |
|---|---|---|---|---|
| 2007 | 1565 | 14,394 | ytf | 96 |
| | | | cod | 114 |
| | | | had | 56 |
| 2008 | 3325 | 31,885 | ytf | 117 |
| | | | cod | 37* |
| | | | had | 33 |
| 2009 | 3431 | 32,556 | ytf | 84 |
| | | | cod | 69 |
| | | | had | 54 |
| 2010 | 3825 | 34,617 | ytf | 200 |
| | | | cod | 44 |
| | | | had | 14 |
| 2011 | 3569 | 25,782 | ytf | 51 |
| | | | cod | 29 |
| | | | had | 15 |
| 2012 | 2973 | 19,031 | ytf | 46 |
| | | | cod | 41 |
| | | | had | 28 |

**Discards from the Canadian scallop fishery on Georges Bank for 2007 and 2008 were adjusted for minor changes in input data from two 2007 trips and two 2008 trips. For 2007, this did not result in any change in the total estimated discards, however, for 2008, this update resulted in an increase of 1 t for cod.*

## Survey

The survey index for recruits (85-95 mm) and fully recruited (≥95 mm) scallops were above their respective 31-year median levels in 2012 (Figure 3) while the index for pre-recruits (<85 mm) were at the 31-year median level. The abundance of recruits and fully recruited scallops has decreased from 120 and 182 scallops per tow in 2011 to 58 and 158 scallops per tow in 2012 respectively (Figure 3).

Shell heights at age measured from shells collected on the survey were used to estimate a new set of growth parameters to replace outdated ones used in previous assessments. These new growth parameters resulted in a change in what shell height size range is considered recruit size. The recruit size range is generally defined as the scallops that will reach commercial size within one year which using the old parameters was 75-95 mm since 1996 but now using the new parameters is 85-95 mm (Figure 3 and 4).

Shell height and meat weight data from the survey were analyzed to see how the condition varies over time. Condition refers to the meat weight relative to shell height and fluctuates depending on environmental variables that vary annually and spatially. The overall condition factor for Georges Bank 'a' in August 2012 was 16.07 g/dm$^3$ (meaning that on average a scallop with a 100 mm shell would have an 16.07 g meat). This was above the long term mean of 15.05 g/dm$^3$ (Figure 5).

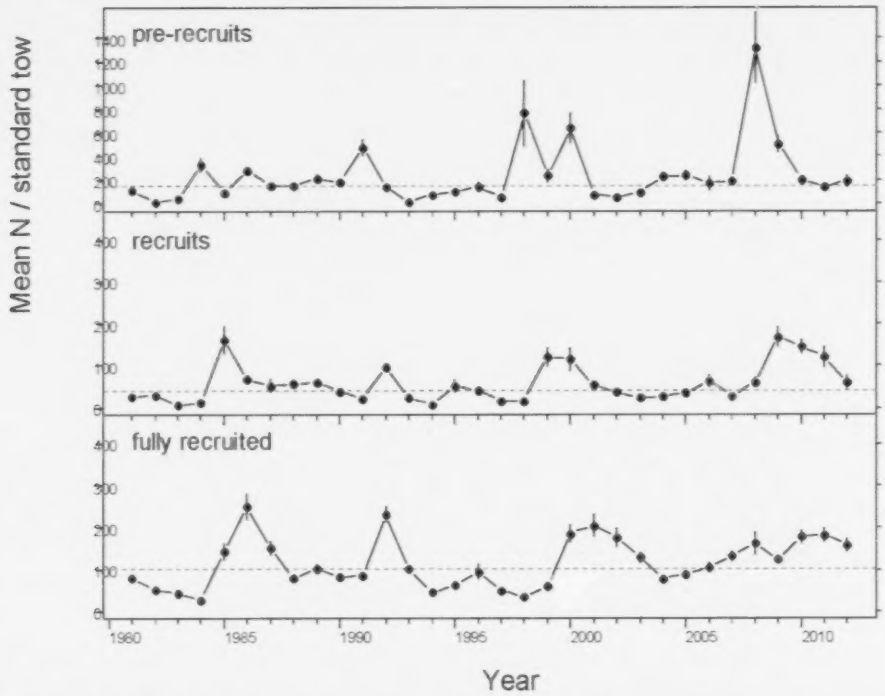


*Figure 3. Survey abundance indices (mean number/standard tow) for pre-recruit (<85 mm since 1996, <75 mm from 1986-1995 and <60 mm before 1986), recruit (85-95 mm since 1996, 75-85 mm from 1986-1995 and 60-75 mm before 1986) and fully recruited (≥95 mm since 1996, ≥85 mm from 1986-1995 and ≥75 mm before 1986) scallops. The dashed lines are the 29-year median value for each size class.*

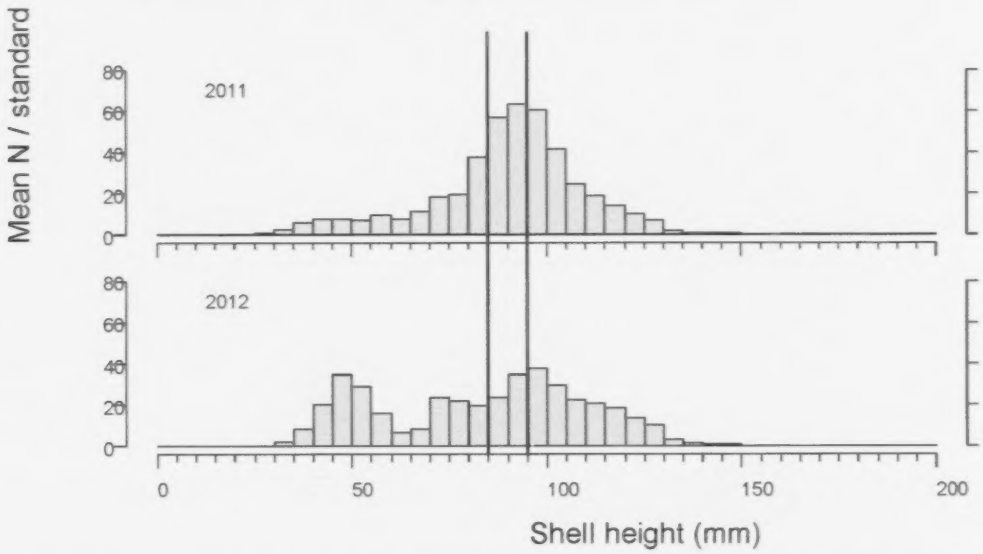


*Figure 4. Mean number of scallops at shell height (mean number/standard tow) from the Georges Bank 'a' survey. The vertical lines indicate the divisions between pre-recruit, recruit and fully recruited size classes.*

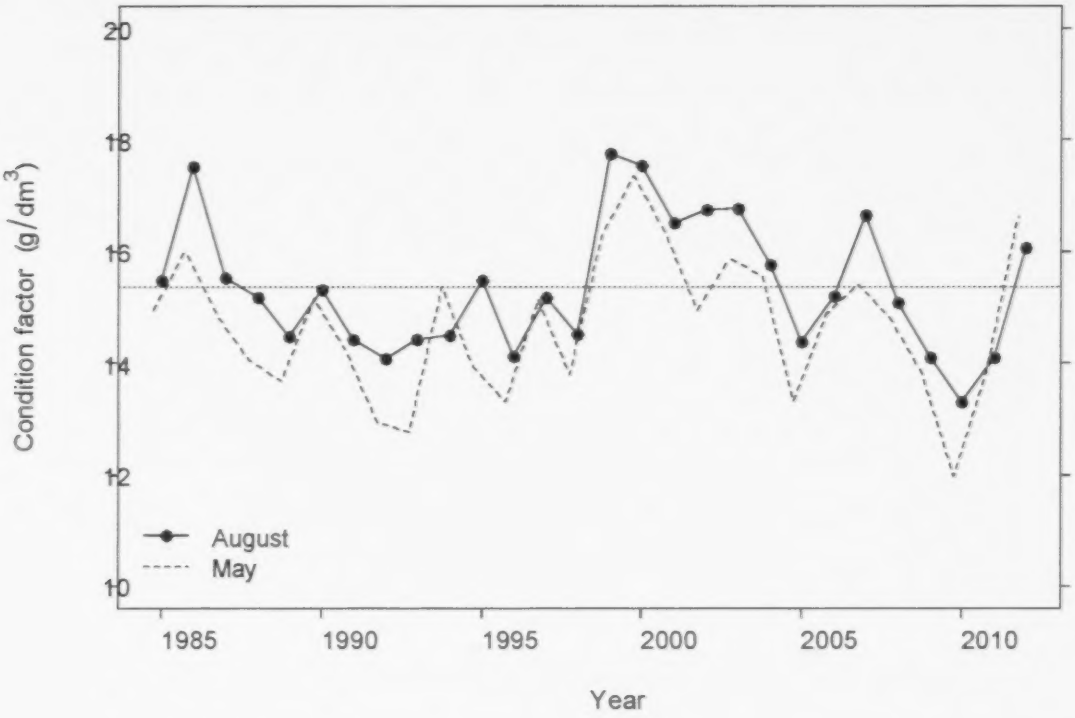


*Figure 5. Overall annual condition factor calculated from shell height and meat weight data collected from the August and May surveys. The horizontal dashed line is the 27-year mean value for the August survey.*

## Population Model

The stock assessment model, described in Jonsen et al. (2009) with recent improvements described in Hubley et al. (2013), was fit to the annual survey and commercial catch rate indices on Georges Bank 'a' from 1986 to 2012 to estimate commercial biomass and exploitation, as well as to provide 2013 biomass projections and harvest scenarios. Improvements included considering fishery data between surveys (September in year t to August in year t+1), and incorporating standard errors from the indices into estimates of observation error in the model. Non-harvest mortality, and its uncertainty, was estimated using an index of dead scallops (paired shells) from the survey, effectively accounting for the lack of reliable information with regard to mortality resulting from discards, incidental fishing and natural sources. Changes in annual condition were also included in the growth estimates along with new growth parameters from recent age data.

Fully recruited biomass, estimated to be 23,400 t in 2012, increased from the 2011 estimate (21,370 t) and is above the 26-year median biomass of 14,810 t (Figure 6). Recruit biomass, estimated to be 4,685 t in 2012 declined from the 2011 estimate (7,657 t), but is still above the 26-year median biomass of 2,995 t. There is an extremely high probability (>0.99) that the 2012 biomass is currently above the upper stock reference (USR) and in the healthy zone. The model's forecast for 2013 biomass is 26,210 t, assuming a catch of 4,000 t (the interim TAC), no change in condition and natural mortality rates similar to 2012. This represents an estimated 11 % increase in biomass from 2012. Exploitation declined in 2012 to 0.16 from 0.19 in 2011 (Figure 7). The estimates of non-harvest mortality decreased for both recruit and fully-recruited scallops to 0.06 and 0.04 in 2012, from 0.28 and 0.13 in 2010, respectively (Figure 7).

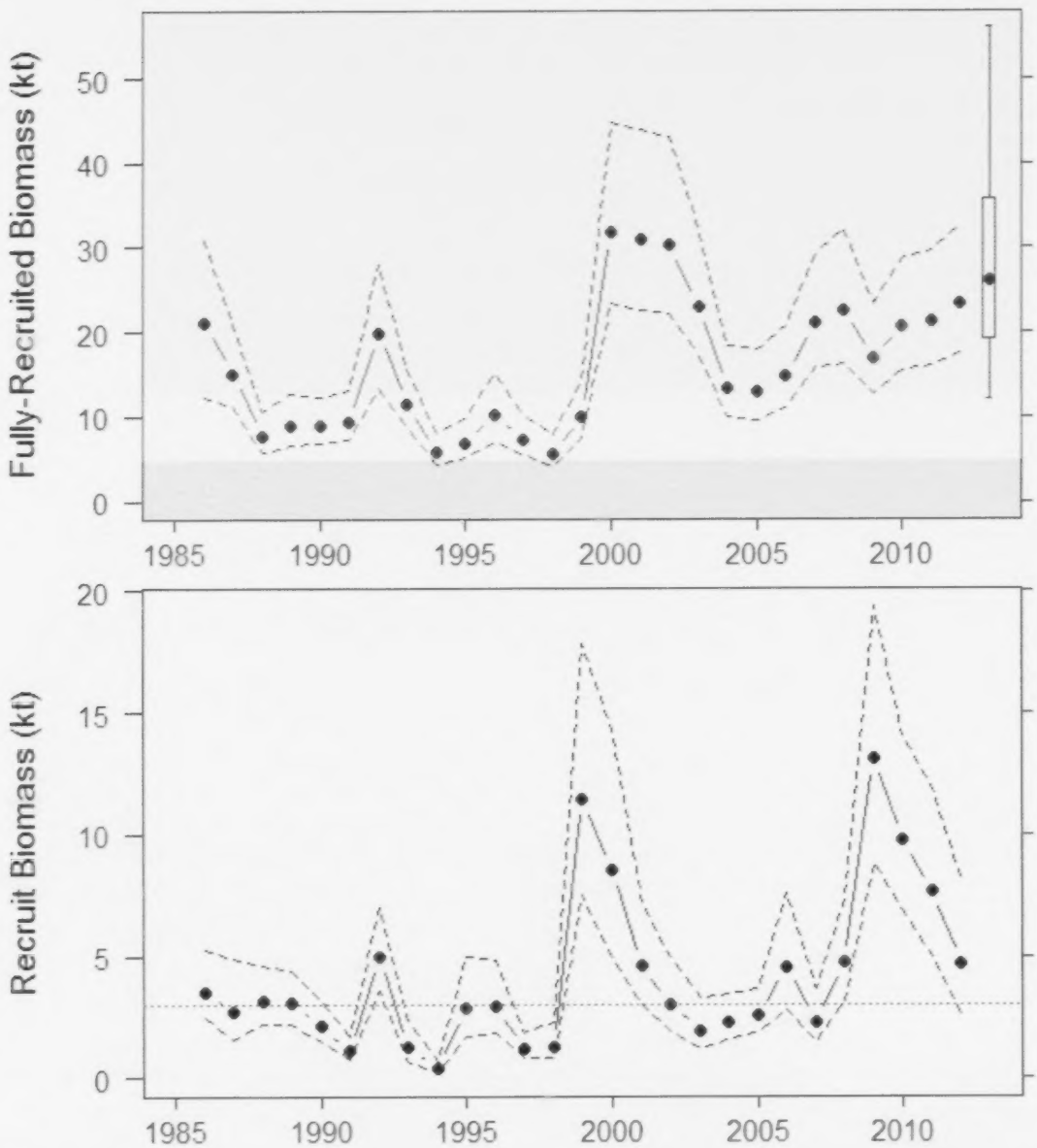


*Figure 6. Biomass estimates for recruit and fully recruited scallops from the stock assessment model fit to the Georges Bank 'a' survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. Coloured zones represent the healthy (green), cautious (yellow) and critical (red) when reference points are calculated as 80% and 30% of mean biomass. and the dotted line represents the 26 year median for recruitment. The forecasted fully recruited biomass for 2013, assuming a catch of 4,000 t, is displayed as a box plot with median (•), 50% credible limits (box) and 80% credible limits (whiskers).*

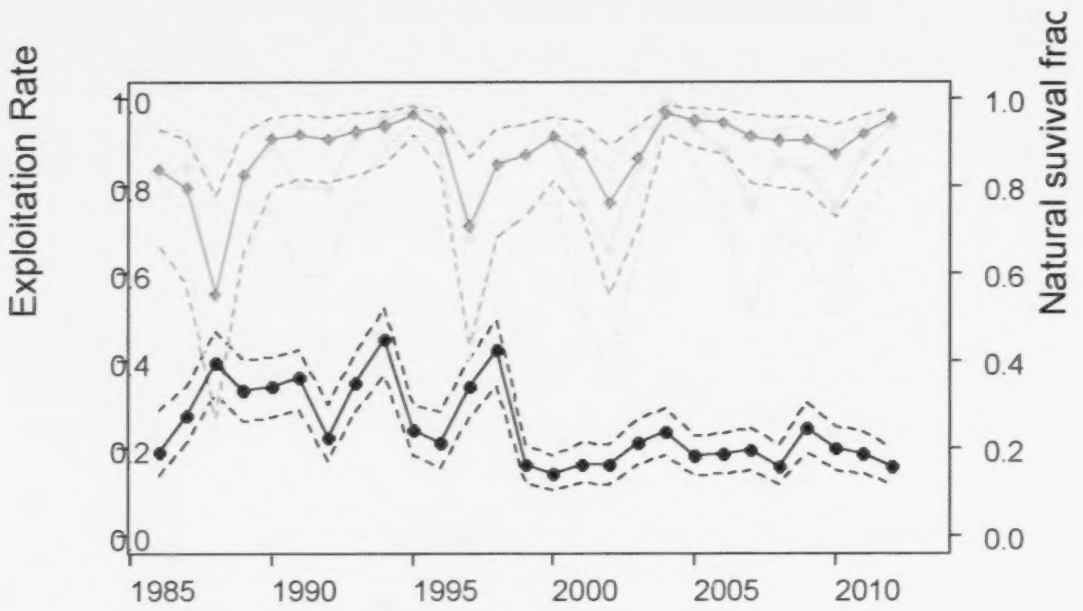


*Figure 7. Annual trends in exploitation (black line, circles) and survival estimates (exp(-m)), where m is natural mortality of fully recruited (grey line, squares) and recruit size scallops (green line, squares). Dashed lines are the upper and lower 95% credible limits on the estimates.*

## Sources of Uncertainty

Annual changes in condition are accounted for in the growth estimates from year to year but projections from the model assume no change in condition for 2013 because that data is not yet available. If condition declines or increases growth will likely be lower or higher than expected. Estimated parameters for shell growth are based on recent age data and do not account for annual vaiability although shell growth is expected to be less variable than condition.

## CONCLUSIONS AND ADVICE

Fully recruited (commercial) biomass has been above 10,000 t since 2000. This was due to a combination of large recruit cohorts 1999 and 2009 (Figure 6), a shift by industry to generally lower exploitation rates, and the adoption of an industry-implemented protocol on a minimum landed scallop size from 1995 onward.

The 2013 interim TAC of 4,000 t results in an exploitation rate of 0.16, and incoming recruitment is expected to be above the median. Harvest scenarios ranging from 2,000 t to 6,000 t are predicted to yield increases in commercial biomass with a probability of decline ranging from 0.36 to 0.48 (Table 3). The probability that biomass will remain in the healthy zone was high (>0.86) for all harvest scenarios presented (Table 3).

*Table 3. Harvest scenarios for Georges Bank 'a' in 2013 in terms of exploitation and expected changes in biomass. Potential catches in 2013 are evaluated in terms of the probability of a decline in biomass and exceeding reference points. These probabilities account for uncertainty in the biomass forecasts.*

| Catch (t) | Exploitation Rate | Probability of Biomass Decline | Expected Change in Biomass (%) | Probability biomass will exceed USR | Probability biomass will exceed LRP |
|---|---|---|---|---|---|
| 2000 | 0.09 | 0.36 | 21.17 | 0.92 | >0.99 |
| 2500 | 0.11 | 0.38 | 18.43 | 0.92 | >0.99 |
| 3000 | 0.12 | 0.39 | 16.40 | 0.91 | >0.99 |
| 3500 | 0.14 | 0.40 | 14.19 | 0.90 | >0.99 |
| 4000 | 0.16 | 0.42 | 11.25 | 0.89 | >0.99 |
| 4500 | 0.18 | 0.44 | 8.41 | 0.89 | >0.99 |
| 5000 | 0.19 | 0.46 | 5.26 | 0.88 | >0.99 |
| 5500 | 0.21 | 0.47 | 4.28 | 0.87 | >0.99 |
| 6000 | 0.22 | 0.48 | 2.00 | 0.86 | >0.99 |

## SOURCES OF INFORMATION

This Science Advisory Report is from the May 1, 2013, Assessment of Georges and Browns Bank Scallop. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Gavaris, S., J. Sameoto, A. Glass, and I. Jonsen. 2009. Discards of Atlantic Cod, Haddock, and Yellowtail Flounder from the 2008 Canadian Scallop Fishery on Georges Bank. TRAC Ref. Doc. 2009/06.

Hubley, P.B., Reeves, A., Smith, S.J., and Nasmith, L. 2013. Georges Bank 'a' and Browns Bank 'North' Scallop (*Placopecten magellanicus*) Stock Assessment. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/079.

Jonsen, I.D., A. Glass, B. Hubley, and J. Sameoto. 2009. Georges Bank 'a' Scallop Framework Assessment: Data Inputs and Population Models. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/034.

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